LESSON 7: CONVERTING THE GRID-MAGNETIC ANGLE

PURPOSE

In this lesson, we will show you how to use the **declination** diagram to convert grid azimuths to magnetic azimuths and vice versa. Converting the **Grid-Magnetic Angle** is one of the most difficult tasks to understand in map reading. Therefore, this lesson presents simple step-by-step procedures for converting the G-M angle.

arc
declination
grid convergence
Grid-Magnetic (G-M)
 Angle

THE DECLINATION DIAGRAM

Mapmakers place the declination diagram in the lower margin of most topographic maps.

Declination is the angular difference between true north and either magnetic or grid north. There are two declinations, a magnetic declination and a grid declination. The declination diagram shows the angular relationship, represented by prongs, between the three norths (see Illustration 2.7.1). However, the position of the three prongs in relation to each other varies according to the declination data for each map.
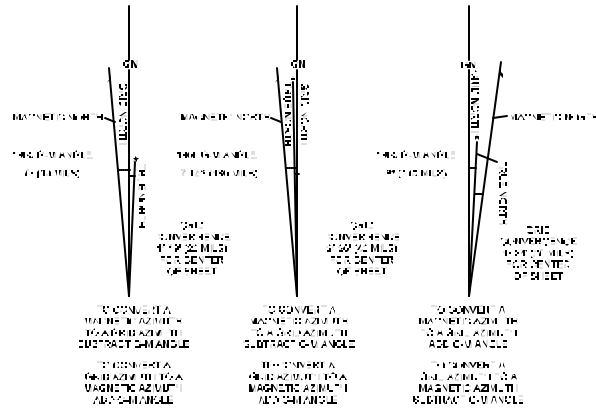

Illustration 2.7.1

Furthermore, mapmakers usually do not plot the angles between the prongs exactly to scale. Although you can obtain the position of the norths in relation to each other from the diagram, you should not measure the numerical value from it. For example, if the amount of declination from grid north to magnetic north is one degree, the **arc** shown on the diagram only represents the direction of the declination and the diagram may exaggerate its value. If measured, the declination may have an actual value of five degrees.

THE GRID-MAGNETIC (G-M) ANGLE

The Grid-Magnetic Angle, or the G-M angle, is the angular size that exists between grid north and magnetic north in the year that mapmakers prepared the angular size. It is an arc, indicated by a dashed line, that connects the grid-north and magnetic-north prongs. Maps express this value to the nearest one-half (1/2) degree with mil equivalents shown to the nearest 10 mils. The G-M angle is important in map reading because it helps a user to apply direction to an object that is on a map to its actual direction on the ground and vice versa.

GRID CONVERGENCE

The **grid convergence** is an arc indicated by a dashed line connecting the prongs

for true north and grid north. The value of the angle for the center of the sheet is given to the nearest full minute (of degrees) with its equivalent to the nearest mil. Mapmakers show these data in the form of a grid-convergence note.

CONVERSION

There is an angular difference between the grid north and the magnetic north caused by the attraction of the earth's magnetic field (found in Northern Canada). Since all compasses point toward magnetic north, the location of this magnetic field does not match exactly with the grid-north lines on the maps. Therefore, a conversion from magnetic to grid, or vice versa, is needed.

Conversion With Notes

If the declination diagram on a map provides conversion notes explaining the use of the G-M angle, simply refer to them. One note gives instructions for converting a magnetic azimuth to a grid azimuth. The other shows how to convert a grid azimuth to a magnetic azimuth. The conversion (to add or subtract) depends on the direction of the magnetic-north prong relative to the grid-north prong.

Conversion Without Notes

Some maps, however, do not contain these declination conversion notes. Thus, it is necessary to convert from one type of declination to another. A magnetic compass gives a magnetic azimuth, but in order to plot this line on a map with grid lines, you must change the magnetic azimuth value to a grid azimuth value. Therefore, you must use the declination diagram for these conversions. A rule to follow when solving such problems is "starting from the reference line, <u>always</u> measure the angle to the azimuth line in a clockwise direction." With this rule in mind, you can now solve the prob-

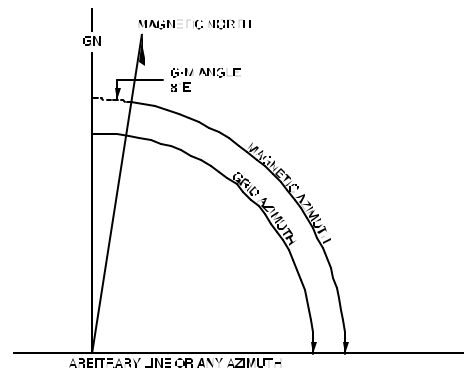lem using the following steps (see Illustration 2.7.2).

Illustration 2.7.2

1. Draw a vertical, or grid-north, line (prong). Always align this line with the vertical lines on the map.

> The first application will be to convert an east magnetic azimuth to a grid azimuth (see Illustration 2.7.3).

2. From the base of the grid-north line, draw a direction line (or an azimuth line) at roughly a right angle from north, regardless of the actual value of the azimuth in degrees.

3. Examine the declination diagram on the map and determine the direction of the magnetic north (right-left or east-west) relative to that of the grid-north prong. Draw a magnetic prong from the base of the grid-north line in the desired direction.

4. Determine the value of the G-M angle by drawing an arc from the grid prong to the magnetic prong and placing the value of the G-M angle above the arc.

5. Complete the diagram by drawing an arc from each reference line to the vertical line you first drew. A glance at the completed

diagram shows whether the given or desired azimuth is greater, and thus whether you must add or subtract the known difference between the two azimuths.

> The second application will be to convert an east grid azimuth to a magnetic azimuth (see Illustration 2.7.4).

6. The inclusion of the true-north prong in relationship to the conversion is of little importance.

APPLICATIONS OF THE G-M ANGLE CONVERSION

For the remainder of this lesson, we will show you how to apply this conversion technique when you have an east G-M angle, a west G-M angle, and when the G-M angle is greater than the magnetic or grid azimuth. You will also have an opportunity to practice converting the G-M angle in the Chapter Review immediately following this lesson.
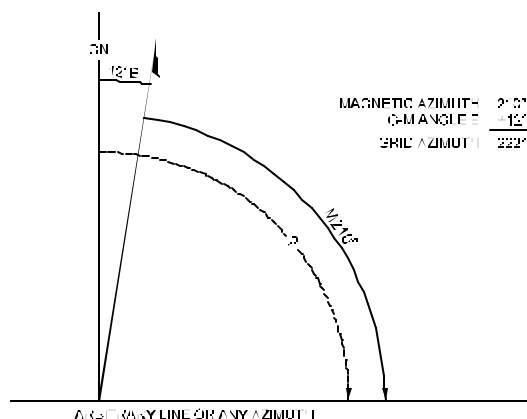
Working With an East G-M Angle

Illustration 2.7.3

To plot a magnetic azimuth of 210 degrees on a map, you must convert it to a grid azimuth.

1. First, determine the declination in degrees. In this example, it is 12 degrees east (see Illustration 2.7.3).

2. Then, since the arc from magnetic north to the azimuth line is shorter than the arc from grid north to the azimuth line, you must *add* the G-M angle. This yields a grid azimuth of 222 degrees.
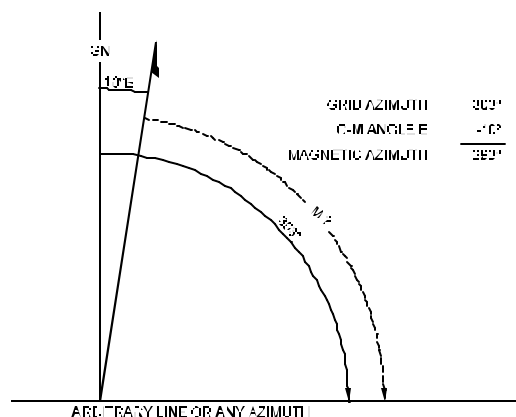

Illustration 2.7.4

To use a magnetic azimuth in the field with a compass when you have a grid azimuth of 303 degrees, you must convert it to a magnetic azimuth.

1. First, determine the declination in degrees. In this example, it is 10 degrees east (See Illustration 2.7.4).

2. Then, since the arc from grid north to the azimuth line is longer than the arc from magnetic north to the azimuth line, you must *subtract* the G-M angle. This yields a magnetic azimuth of 293 degrees.

The third application will be to convert to a magnetic azimuth when the G-M angle is greater (see Illustration 2.7.5).
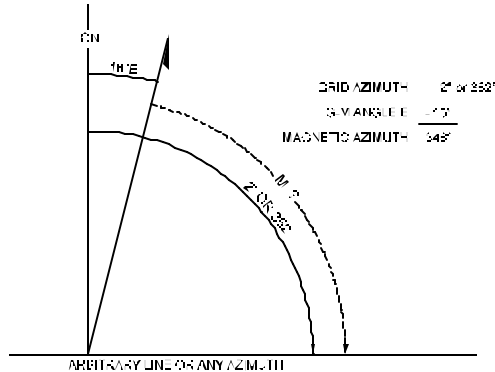
The fourth application will be to convert a west magnetic azimuth to a grid azimuth (see Illustration 2.7.6).

Illustration 2.7.5

In converting a grid azimuth to a magnetic azimuth, when the G-M angle is greater than the grid azimuth, first do the following:

1. Add 360 degrees to the grid azimuth. In this example, the grid azimuth is 2 degrees (see Illustration 2.7.5) (**Note:** Since there are no negative azimuths on the azimuth circle, 0 degrees is the same as 360 degrees. Therefore, 2 degrees [in this example] is the same as 362 degrees. This is because 2 degrees and 362 degrees are located at the same point on the azimuth circle.) You can now convert the grid azimuth to a magnetic azimuth because the grid azimuth is larger than the G-M angle.

2. This procedure is the same as Step 2 in the last example. Since the grid north arc of 362 degrees is longer than the arc from magnetic north to the azimuth line, you must *subtract* the G-M angle. This yields a magnetic azimuth of 346 degrees.
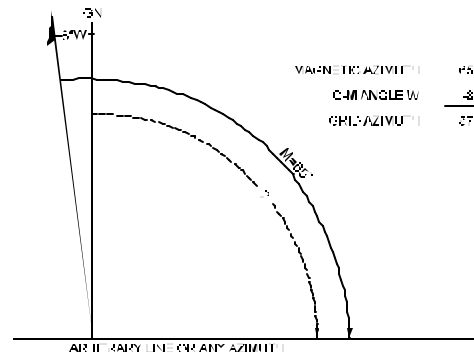
Working With a West G-M Angle

Illustration 2.7.6

To plot a magnetic azimuth of 65 degrees on a map, you must convert it to a grid azimuth.

1. First, determine the declination in degrees. In this example, it is 8 degrees west (see Illustration 2.7.6).

2. Then, since the arc from magnetic north to the azimuth line is longer than the arc from grid north to the azimuth line, you must *subtract* the G-M angle, giving you a grid azimuth of 57 degrees.

To use a magnetic azimuth in the field with a compass when you have a grid azimuth of 93 degrees, you must convert it to a magnetic azimuth.

The fifth application will be to convert a west grid azimuth to a magnetic azimuth (see Illustration 2.7.7).
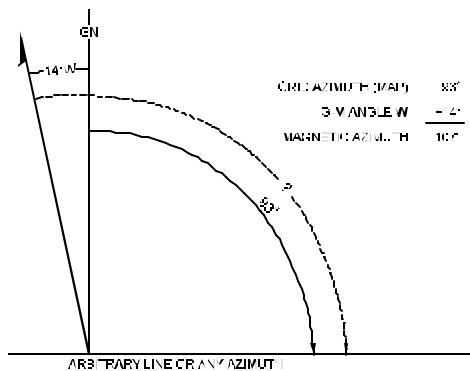
Illustration 2.7.7

1. First, determine the declination in degrees. In this example, it is 14 degrees west (see Illustration 2.7.7).

2. Then, since the arc from grid north to the azimuth line is shorter than the arc from magnetic north to the azimuth line, you must *add* the G-M angle. This yields a magnetic azimuth of 107 degrees.
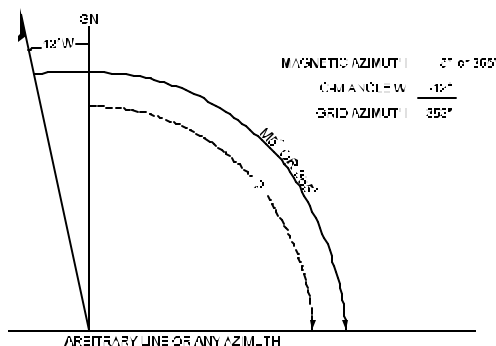

Illustration 2.7.8

In converting a magnetic azimuth to a grid azimuth, when the G-M angle is <u>greater</u> than the magnetic azimuth, first do the following:

1. Add 360 degrees to the magnetic azimuth. In this example, the magnetic azimuth is 5

degrees (see Illustration 2.7.8). (**Note:** Since there are no negative azimuths on the azimuth circle, 0 degrees is the same as 360 degrees. Therefore, 5 degrees [in this example] is the same as 365 degrees. This is because 5 degrees and 365 degrees are located at the same point on the azimuth circle.) You can now convert the magnetic azimuth to a grid azimuth because the magnetic azimuth is larger than the G-M angle.

2. Since the magnetic north arc of 365 degrees is longer than the arc from grid north to the azimuth line, you must *subtract* the G-M angle. This yields a grid azimuth of 353 degrees.

Each time you convert a G-M angle, construct a G-M angle diagram that shows the required azimuths. The construction of a diagram takes the guesswork out of converting azimuths when the map does not give any conversion notes.

> The final application will be to convert to a grid azimuth when the G-M angle is greater (see Illustration 2.7.8).

Converting the G-M angle requires practice. Become familiar with the proper procedures to follow whether there is an east or west G-M angle, or the G-M angle is greater than your grid or magnetic azimuth.

CONCLUSION

In this lesson, we presented map reading skills that you can use not only in later map reading instruction, but also in many practical ways. We discussed how to determine distance

and direction (with a protractor and a compass) between two points. We also investigated how to convert the Grid-Magnetic Angle using a grid azimuth from a map or a magnetic azimuth from a compass. Mastering these skills will help you to navigate more effectively when the challenge arises.

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